Bioclean TM

Reduces Total Nitrogen Concentration in Your Effluent

When denitrification capacity in your system is not enough, Bioclean TM Bioaugmentation significantly lowers effluent Total Nitrogen concentration

How do we do it?

Our heterotrophic species in Bioclean TM are versatile Nitrogen transforming microorganisms capable of carrying out **simultaneous nitrification and denitrification (SND)**, although their mode of action differs fundamentally from that of conventional autotrophic nitrifiers. These organisms are not classical Ammonium-oxidizing or nitrite-oxidizing bacteria such as Nitrosomonas, Nitrobacter, or Nitrospira.

Instead, they belong to the group of heterotrophic nitrifying–aerobic denitrifying (HN-AD) bacteria, in which Ammonium and organic Nitrogen are oxidized via heterotrophic pathways while nitrate and nitrite are reduced to gaseous Nitrogen forms under overlapping operational conditions. This apparent simultaneity is enabled by their metabolic flexibility and by the micro-environments they create during active growth.

Activated sludge flocs enhanced by Bioclean TM, with rapid Oxygen consumption combined with strong tendencies toward floc and biofilm formation generates steep Oxygen gradients within microbial aggregates. The outer regions of these structures remain sufficiently oxygenated to support heterotrophic nitrification, while inner zones become Oxygen-limited or anoxic, allowing denitrification enzymes to function concurrently. The bacteria possess Nitrate and Nitrite reductase systems, and in several strains the downstream reduction of Nitric Oxide and Nitrous Oxide has also been demonstrated, enabling effective conversion of oxidized Nitrogen intermediates to Dinitrogen gas. As a consequence, Ammonium removal often occurs without the accumulation of Nitrite or Nitrate, **resulting in net Total Nitrogen reduction even under nominally aerobic conditions.** Importantly, these processes do not rely on the classical Ammonia monooxygenase pathway, and genes such as amoA are generally absent, confirming that the nitrification step is heterotrophic rather than autotrophic in nature.

Our species have **exceptional ability to adapt rapidly to changing Oxygen regimes**. Unlike obligate autotrophic nitrifiers, our species can maintain Nitrogen transformation activity across a broad Dissolved Oxygen range, switching seamlessly between aerobic respiration and Nitrate or Nitrite reduction without metabolic collapse. **This flexibility makes them particularly well suited to real wastewater environments**, where stable and narrowly controlled operating conditions are rarely achievable.

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When compared with conventional autotrophic nitrifiers, **heterotrophic SND strains offer several practical and operational advantages.** Autotrophic nitrifiers are slow-growing, sensitive to organic carbon, and highly vulnerable to fluctuations in temperature, pH, toxic compounds, and hydraulic loading. In contrast, our species grow rapidly, tolerate wide environmental variations, and remain active in high-COD systems where autotrophic nitrification often fails. **Their ability to function at lower Dissolved Oxygen concentration reduces aeration demand and energy consumption, while their resilience enables faster recovery from shock loads and process upsets.** For these reasons, they should not be viewed as direct replacements for canonical nitrifiers in highly specialized systems, but rather as robust **auxiliary Nitrogen transformers** that stabilize and enhance overall Nitrogen removal performance.

Persistent nitrification failures in wastewater treatment systems are often misdiagnosed when operators attempt to restore Ammonium removal by supplementing pure cultures of Nitrosomonas and Nitrobacter. Such approaches frequently underperform because they introduce slow growing, ecologically fragile chemolithoautotrophic bacteria into systems already dominated by fast-growing heterotrophs. In these competitive environments, supplemented nitrifiers are typically washed out faster than they can establish stable populations, especially under high organic loading or low-temperature conditions. **In contrast, heterotrophic organisms like we have in Bioclean TM enhance Nitrogen removal not by direct competition, but by restructuring the microbial ecosystem itself.**

The critical distinction lies in metabolic versatility and ecosystem engineering. Heterotrophic bioaugmentation organisms construct the physical and chemical framework—through biofilm formation, extracellular polymer production, Oxygen gradient creation, and pH stabilization—that enables both heterotrophic SND and the persistence of native nitrifiers within protected microhabitats. **Rather than competing with autotrophic nitrifiers for Ammonium, these organisms facilitate conditions in which multiple Nitrogen transformation pathways can coexist and remain stable.** This indirect but powerful mechanism becomes particularly important under challenging operational scenarios, including cold climates and variable loading regimes, where conventional nitrification strategies often collapse. In such systems, **Bioclean TM optimized heterotrophic SND approaches represent a more realistic, resilient, and sustainable route to long-term Nitrogen removal** than reliance on pure autotrophic nitrifier supplementation alone.

Applicable at:

Industrial, and municipal **activated sludge, granular sludge, MBBR** wastewater treatment plants, both at continuous flow, or SBR technologies, aerated lagoons, oxidation ditches, trickling filters, rotating biological contactors.

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